Anirudh **Singhal**

Senior Undergraduate

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Research Interests

Machine Learning, Computer Vision, Markov Decision Processes, Online Learning, Multi-Armed Bandits and Applied Probability

Education

Indian Institute of Technology Bombay — *Mumbai, India*

Dual Degree (B.Tech and M.Tech) in Electrical Engineering and Minor in Computer Science and Engineering — *Jul. 2016 - exp. Jun. 2021*

- Specialization : Communication and Signal Processing, Major GPA : **9.43/10**, Minor GPA : **9.75/10**

Technical University of Denmark — *Lyngby, Denmark*

Student Exchange Program in Computer Science and Electrical Engineering — *Aug. 2019 - Dec. 2019*

- Secured a Grade Point Average of **12/12**

Publications and Patents

- Publication : Towards a Unified Framework for Visual Compatibility Prediction,
  A. Singhal*, A. Chopra*, K. Ayush*, U. Patel* and K. Balaji; *2020 IEEE Winter Conference on Applications of Computer Vision (WACV), 1-5 March 2020, Snowmass Village, Colorado, USA* [Link]
  *equal contribution
- Patent : Deep Learning Based Visual Compatibility Prediction For Bundle Reccomendations,
  Filed in US Patent and Trademark Office on May, 2020

Research Experience

Adaptive Mode Estimation of Continuous Distribution — *IIT Bombay*

Guide : Prof. Nikhil Karmachandani, Electrical Engineering — *Jan. 2020 - Present*

Introduction : We develop an algorithm to find the mode of a dataset with an underlying continuous distribution, by adaptively estimating the point with k^{th} nearest neighbour (KNN) using Multi-Armed Bandits algorithms. Instead of using all the dimensions we randomly sample dimensions to get an unbiased estimate of the distance which can lead to computational gains for high-dimensional datasets.

- Proposed an information theoretically optimal algorithm which can adaptively estimate the KNN distance of a point with high probability
- Used this algorithm to adaptively find the point with the nearest KNN which corresponds to mode of the dataset
- Achieved a 90% reduction in the number of queries as compared to the naive approach to find the point with the nearest KNN

Holistic Deep Learning based solutions for Fashion Compatibility — *Adobe Inc., Noida*

Research Intern — *May 2019 - Jul. 2019*

Introduction : Fashion compatibility prediction refers to the task of determining if a set of clothing items go well together. Existing techniques for compatibility prediction prioritize sensitivity to type or context in item representations and evaluate using a fill-in-the-blank (FITB) task.

- Scaled the FITB task by increasing the number of options to stress-test existing methods which highlights their degradation of performance by increasing the number of options and the need for a unified compatibility framework
- Introduced a unified framework for compatibility learning that consists of three major components. A type conditioned Graph Convolutional Network that models type and context of an item, an attention based Style Autoencoder that extracts style of an outfit by projecting it on a style basis and finally a Reinforcement Learning based search technique that incorporates these modalities to learn a unified compatibility measure
- The new model significantly outperforms the existing state-of-the-art models on the two standard datasets

Reduced Feedback Techniques for Kerdock based MIMO-OFDM Precoders — *IIT Bombay*

Guide : Prof. Appaiah Kumar, Electrical Engineering — *Jan. 2020 - Jun. 2020*

Introduction : Kerdock Codes are a new type of precoders which can provide computational and storage benefits over the traditional precoders. Feedback reduction coupled with benefits of Kerdock codes could lead to drastic data rate improvements in MIMO-OFDM systems.

- Conducted an extensive literature survey in the fields of linear precoders and feeedback reduction techniques for MIMO-OFDM precoders
- Implemented clustering and geodesic based interpolation techniques to reduce feedback requirements with low error rate

Digitally Programmable Analog Computer

IIT Bombay

Guide : Prof. Mukul Chandorkar, Electrical Engineering

Jan. 2019 - Apr. 2019

Introduction : Numerous engineering problems can be modelled as a non-linear multi-state differential system. Analog methods of solving them are extremely fast. Unlike digital systems, however, they are inaccurate, susceptible to noise and lack mathematical flexibility to express non-linearities. A hybrid solution presents the best of both worlds.

- Proposed use of a hybrid system to solve non-linear differential equations in up to eight state variables
- Designed an analog module using integrator blocks for fast computations over a wide frequency range and interfaced it with a digital module consisting of a fast microcontroller to compute non-linear expressions
- Designed the whole circuit on EagleCad and fabricated it on a two-layer printed circuit board with on-board power management

Work Experience

In-House Web App Analytics Service

OkCredit, Bangalore

Summer Intern

May 2018- Jul.2018

Introduction : OkCredit is a growing startup which provides a mobile based digital ledger for small businesses in India that extend credit to their customers. Designed the infrastructure to collect user interactions from mobile app for targetted communication with them.

- Built a server in Google Go to store user interaction data in a Cassandra database and transfer it to Amazon S3 daily
- Created an Android Library to store the user interaction data locally and send it to the server at regular intervals
- Developed user authentication service in Google Go based on Oauth 2.0 for mobile and web applications.
- Devised and performed unit and load tests of REST APIs to calculate their maximum load as function of resources

Key Projects

RISC Processor Design

IIT Bombay

Guide : Prof. Virendra Singh, Electrical Engineering

Jul. 2018 - Nov. 2018

Designed a 16 bit Multi-Cycled Reduced Instruction Set Computer (RISC) microprocessor having arithmetic operations, branch and jump instructions and designed a pipelined version of the same Instruction set Architecture (ISA). Simulated the design in VHDL and verified the working with Register Transfer Logic followed by flashing the code on a FPGA.

Texture Synthesis by Non-parametric Sampling

IIT Bombay

Guide: Prof. Ajit Rajwade & Suyash Awate, Computer Science Engineering

Sep. 2018 - Nov. 2018

Synthesized a texture from an initial seed on MATLAB which was used for hole filling and image expansion. Modelled the image as a Markov Random Field (MRF) to find probability distribution of a pixel to be predicted

Electrical Subsystem, Advity

IITB Student Satellite Project

Advity is the second student satellite of IIT Bombay

Feb. 2017 - Mar. 2019

Critically analyzed various parameters and constraints to finalize the microcontroller of On Board Computer which runs Attitude Determination and Controls algorithms. Proposed the use of Real Time Operating System (RTOS) to carry out the scheduling of tasks being run on the On Board Computer and conceptualized a scheduling algorithm for the same.

Markov Chain Monte Carlo Convolutional Decoder

IIT Bombay

Guide: Prof. Prasana Chaporkar, Electrical Engineering

Mar. 2019 - Apr. 2019

Proposed a convolutional decoder based on Markov Chain Monte Carlo simulations. The proposed decoder performs comparable to the state of the art convolutional decoders such as viterbi decoder for Additive White Gaussian Noise (AWGN).

Technologies For Soldier Support

IIT Madras

Represented IIT Bombay in Inter IIT Tech Meet

Dec. 2017 - Jan. 2018

Fabricated a smart glove using flex sensors and accelerometer to detect soldier's hand gestures using decision trees to help soldiers communicate with each other in poor visibility. Built a headband which could monitor Soldier's important physiological parameters such as heartbeat, temperature and head impact force using optical pulse sensor, temperature sensor and accelerometer so that soldiers can get faster medical attention.

Lazy Lock : Automatic Lock

IIT Bombay

Institute Technical Summer Project

May 2017 - Jun. 2017

Designed and implemented an automated door unlocking mechanism which unlocks by gesture detection, knock pattern and remotely from an android app. Implemented Image Processing algorithms using OpenCV on RaspberryPi (RPi) for gesture recognition. Improved gesture recognition accuracy by employing Machine Learning using scikit-learn in python. Integrated RPi with knock detector circuit such that it unlocks only on a unique knock pattern.

Scholastic Achievements

- Awarded AP Grade for outstanding performance in the course on Network Theory and Markov Chains and Queuing Systems *2019*
- Secured All India Rank 368 amongst 1.5 lakh candidates in JEE Advanced *2016*
- Recipient of prestigious Kishore Vaigyanik Protsahan Yojana(KVPY) Scholarship *2015*
- Awarded certificate of merit for statewise top 1% in National Standard Examination in Physics *2015*
- Qualified for Indian National Chemistry Olympiad (INChO) based on performance in National Standard Examination in Chemistry *2015*

Key Courses Undertaken

Electrical Engineering	Acoustic Signal Processing, Wireless Communications, Network Security, Signals and Systems, Analog and Digital Systems, Communication Systems, Microprocessors, Non-Linear Dynamics
Computer Science	Advanced Machine Learning, Digital Image Processing, Introduction to Machine Learning, Operating Systems, Computer Networks, Data Structures and Algorithms
Mathematics and Statistics	Markov Chains and Queuing Systems, Data Analysis and Interpretation, Probability and Random Processes, Matrix Computations, Linear Algebra, Complex Analysis

Technical Skills

Languages	Python, Google Go, MATLAB, SQL, VHDL, C, C++, Embedded C, Java
Micro-controller Programming	Atmel Studio, ArduinoIDE, RPi
Simulation and CAD Softwares	Proteas, NGSpice, SolidWorks, AutoCAD
Other Softwares and Modules	Android Studio, TensorFlow, PyTorch, OpenCV, Scikit-Learn, Git, Quartus

Positions of Responsibility

Subsystem Leader, Electrical Subsystem, Advity *IITB Student Satellite Project*

Advity is the second student satellite of IIT Bombay *Feb. 2018 - Mar. 2019*

- Spearheaded a 10 membered inter-disciplinary team of two subdivisions, Power and On-Board Computer to design the power distribution circuit, interface with peripherals and implement the control algorithm
- Ensured implementation of Quality Assurance Practices to guarantee 100% reliability
- Recruited 9 candidates from over 100 applicants by conducting a 3 stage selection procedure which tested technical and practical skills
- Contributed to Satellite 101 wiki, a compilation of exhaustive knowledge of satellite project which reached 5.8k page views within a month

Teaching Assistant, Differential Equations *IIT Bombay*

Prof. Swapneel Mahajan, Department of Mathematics *Jan. 2019 - Apr. 2019*

Responsible for grading tests and conducting weekly tutorials for a class consisting of 50+ students

Extra Curricular Activities

- Social Work :
  - Volunteered in NGO Vidya for tutoring financially and socially underprivileged children
  - Taught English to college kitchen staff as a part of Adult Literacy Program (ALP), National Social Scheme
  - Devoted 80+ Hours to Social Service under National Service Scheme, IIT Bombay
  - Helped in organizing CURED: a diabetes awareness campaign attempting Guinness World Record for maximum number of glucose level check-ups covering 200+ camps in 10 states
- Successfully completed Mountaineering Adventure Course (MAC) which is affiliated to Government of India and Government of J & K
- Presented Pratham, IIT Bombay Student Satellite in a national exhibition before an audience of over 400
- Anchored Mood Indigo Idol Semi-Final before an audience of over 200 at Asia's largest college cultural festival